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Some sample size tables for forest sampling

by H.B. Stauffer

Province of British Columbia
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Howard B. Stauffer

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ABSTRACT

This report presents a collection of sample size tables for forest sampling. One group of tables expresses sample size as a function of estimated coefficient of variation and prescribed percentage sampling error for simple random sampling using varying levels of confidence. A second group of tables expresses sample size as a function of estimates of density and spacing and prescribed allowable percentage sampling error for density sampling with fixed-area plots (quadrats) using varying levels of confidence.

These tables have been constructed using an iterative scheme on the standard simple random sampling formula for sampling error. It is demonstrated that the "classical" iterative method for calculating sample size does not always converge to a solution. A corrected (convergent) iteration scheme is described and used to calculate the sample sizes for these tables. Examples are included for illustration.

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INTRODUCTION

This report presents a collection of sample size tables for forest sampling. There are two groups of tables, each listing the sample sizes required for prescribed percentage sampling errors at given levels of confidence. The first group is for simple random sampling in general and uses estimated coefficients of variation. The second group is more specifically for density sampling with fixed-area plots (quadrats) and uses estimates of density and spacing.

It will be demonstrated that the "classical" iterative algorithm used by foresters to calculate sample size does not always converge to a solution. A corrected (convergent) iteration scheme will be described and used to construct the tables.[1]

It should be noted that it is often not necessary to use iteration to estimate sample size. If the sample size or extent of variation of the data is fairly large, if the prescribed allowable percentage sampling error is rather arbitrary, or if the estimate of the coefficient of variation is very imprecise, it is usually sufficient to let the Student's t value t=2 (95% confidence level) in the standard formula for sampling error (9) and perform one calculation to determine sample size (Schaeffer et al. 1979). For large sample sizes or coefficients of variation, this estimate for t will be close

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[1]The term "iteration" here refers to the repeated use of the standard formula for sampling error (9) to obtain increasingly better approximations to a solution for sample size. If these repeated calculations asymptotically stabilize to a solution, the iteration process is said to "converge". Otherwise, if these calculations do not stabilize but instead, say, oscillate back and forth between poor approximations to a solution, the iteration process is said to "diverge". More details and some examples illustrating these concepts will be given later.

enough. For arbitrary levels of prescribed allowable sampling error or imprecise estimates of coefficient of variation, a precise technique such as iteration would create a false impression of precision in the calculation of the sample size.

However, an iterative approach may become necessary if sample sizes are small (i.e., ≤ 30), the variation in the data is small, and estimates of variation are fairly precise. Iterative solutions are often mentioned in the forestry literature (Freese 1956 and 1962, UBC Forest Club 1971, Avery 1975, Wensel 1977). When an iterative solution is necessary, the corrected iteration scheme described in this paper should be used. For these situations and more generally to avoid the necessity of calculation, the sample size tables presented here should serve as a handy reference for practicing researchers and foresters.

Throughout this report, sampling will be assumed to be simple random sampling with replacement or without replacement in a "large" population.[2] If the sampling is without replacement in a small population, the ideas of this paper can be generalized using the finite population correction factor. The ideas of this paper can also be incorporated into sample size calculations for other types of sampling such as stratified random sampling (Cochran 1977, Freese 1962, Schaeffer et al. 1979). This paper is an extension of ideas briefly presented in Stauffer (1982).

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[2]Recall that sampling "with replacement" permits members of a population to be sampled more than once, whereas sampling "without replacement" requires that members of a population may not be sampled more than once.

The theory requires that the population be normally distributed but is sufficiently robust to be applied to populations that are "moderately" nonnormal, particularly if they are not heavily skewed.

THE CLASSICAL ITERATIVE ALGORITHM FOR CALCULATING SAMPLE SIZE

The classical iterative algorithm used by foresters to calculate sample size for simple random sampling proceeds as follows.

We shall want to consider a total population of N values $x_1, x_2, \cdots, x_N$ with the following parameters:

(i) mean

$$\mu = \frac{\sum_{i=1}^{N} x_i}{N} \quad , \tag{1}$$

(ii) variance

$$\sigma^2 = \frac{\sum_{i=1}^{N} (x_i - \mu)^2}{N} \quad , \tag{2}$$

(iii) standard deviation

$$\sigma = \sqrt{\sigma^2} \quad , \tag{3}$$

and

(iv) coefficient of variation

$$\gamma = \frac{\sigma}{\mu} \cdot 100\% \quad . \tag{4}$$

From this total population, we shall consider a random sample of n measurements from the population $x_1, x_2, \ldots, x_n$ with the following parameter estimates:

(i) estimate of the mean

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad , \tag{5}$$

(ii) estimate of the variance

$$s^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1} \quad , \tag{6}$$

(iii) estimate of the standard deviation

$$s = \sqrt{s^2} \quad , \tag{7}$$

and

(iv) estimate of the coefficient of variation

$$CV = \frac{s}{\bar{x}} \cdot 100\% \quad . \tag{8}$$

The $(1 - \alpha) \cdot 100\%$ confidence interval estimate for μ is given by $[\bar{x}-E, \bar{x}+E]$ where

$$E = t_{n-1,\alpha/2} \cdot \frac{s}{\sqrt{n}} \tag{9}$$

is the sampling error. $t_{n-1,\alpha/2}$ (henceforth to be denoted by t) is the t

value with $\alpha/2$ probability and n-1 degrees of freedom.[3] Solving for the sample size,

$$n = t^2 \cdot \frac{s^2}{E^2} = t^2 \cdot \frac{(\frac{s}{\bar{x}} \cdot 100\%)^2}{(\frac{E}{\bar{x}} \cdot 100\%)^2}$$

$$= t^2 \cdot \frac{CV^2}{PE^2} = t^2 \cdot Q \quad , \qquad (10)$$

where $PE = \frac{E}{\bar{x}} \cdot 100\%$ is the percentage sampling error and $Q = \frac{CV^2}{PE^2}$.[4] Note that the percentage sampling error is just the relative amount of sampling error (E) compared to the estimated mean ($\bar{x}$).

The classical iterative algorithm used by foresters to calculate sample size uses formula (10) and proceeds as follows. Given an estimated coefficient of variation (CV) and a prescribed allowable percentage sampling error (PE), let $Q = \frac{CV^2}{PE^2}$. Starting with an initial value for n, say

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[3] α is the Type I error, the probability of rejecting a true null hypothesis. Since the confidence interval is two-sided, a t value with $\alpha/2$ probability for each tail is the appropriate value.

[4] These calculations are meant to provide guidelines for constructing the sample size tables and not to be interpreted from a rigorous statistical point of view. They are dependent on a "reasonably" precise estimate for the coefficient of variation (or s). Strictly speaking, n should be viewed as a random variable with one-sided confidence intervals. An F value should be used in formula (10) when s is estimated from a sample of size m (Grosenbaugh 1947, Li 1964, Snedecor and Mood 1946). The estimate s_m^2 from the sample of size m should be multiplied by $F_{n-1,m-1}$ using a prescribed confidence level, since s_n^2/s_m^2 is $F_{n-1,m-1}$ distributed (Freund and Walpole 1980). $F_{n-1,m-1} \cdot s_m^2$ then provides an estimate for s_n^2 with sample size n. In this paper, we let F = 1 which corresponds to a prescribed confidence level of approximately 50% when s is estimated from a small sample size.

Alternatively, a two-stage sampling scheme could be used to provide an "optimal" design for estimating sample size, estimating CV (or s) at the first stage and n at the second stage (Stein 1945, Cox 1952, Seelbinder 1953, Starr 1966, Starr and Woodroofe 1968, Cochran 1977).

$n_0 = 30$, iterate using

$$n_I = t^2_{n_{I-1}-1} \cdot Q \quad , \tag{11}$$

$I = 1, 2, \ldots$, until convergence occurs (i.e., $n_{K+1} = n_K$). A sample size $n = n_K$ then ensures no more than a percentage sampling error PE with $(1-\alpha)\cdot 100\%$ probability.

Table 1 illustrates examples of convergent iterations using formula (11) above (95% confidence level). In the first example, CV = 20% and PE = 10%. Setting the initial value for n at the 0th iteration (I = 0) at $n_0 = 30$, the associated t value with 29 degrees of freedom is $t_{29} = 2.045$. The calculated value then for n, using formula (11), is 16.731. Rounding upward (to be conservative) and moving to the 1st iteration (I = 1), we set $n_1 = 17$ with the associated t value of $t_{16} = 2.120$. The calculated value for n, again using formula (11), is 17.976. Rounding upward and moving to the 2nd iteration (I = 2), we set $n_2 = 18$ with the associated t value of $t_{17} = 2.110$. The calculated n value from (11) is 17.805 which rounds up to $n_3 = 18$. Since $n_3 = n_2$, the iteration process has stabilized to the solution. Hence, in the first example, the classical iteration process for CV = 20% and PE = 10% converges to n = 18. In the second example, classical iteration for CV = 14% and PE = 3% converges to n = 87.

A CORRECTED ITERATION SCHEME

Unfortunately, convergence does not always occur with this classical iterative method. Table 2 illustrates some examples where convergence does not occur (95% confidence level). In the first example, iteration for CV = 8% and PE = 10% diverges, oscillating between $n_K = 4$ and $n_{K+1} = 7$. In the second example, iteration for CV = 3% and PE = 5% again diverges, oscillating between $n_K = 2$ and $n_{K+1} = 59$. Divergent examples like these are common for low values of Q (i.e., $Q \leq 1$).[5]

A mathematically correct (convergent) iteration scheme consists of rewriting formula (10) as

$$\frac{n}{t^2} = Q \quad . \tag{12}$$

Note that $Q\ (= CV^2/PE^2)$ is fixed. Since t is a decreasing function of n, n/t^2 is an increasing function of n. The corrected iteration scheme then consists of choosing the first n, n = 2, 3, ... , such that $n/t^2 \geq Q$.[6]

Table 3 lists some n/t^2 values (95% confidence level). Given an estimated coefficient of variation (CV) and prescribed allowable percentage sampling error (PE), Q can be calculated and compared with Table 3 values to determine sample size (n). For example, if CV = 5% and PE = 8%, then Q = .391 and n = 4 is the first n such that $n/t^2 \geq Q$ (95% confidence level).

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[5]Apparently, since variation is usually fairly large in forestry applications (i.e., CV ≥ PE), this problem with divergence has not been generally recognized (but cf. Grosenbaugh 1947, Freese 1956).

[6]Choosing the first n which satisfies $n/t^2 \geq Q$ ensures that it is the closest integer value which conservatively approximates the solution to (12).

Table 3 resolves the questions of sample size for the examples of Table 2 (95% confidence level). In the first example, CV = 8% and PE = 10%, so Q = .640 and n = 5 is the first n such that $n/t^2 \geq Q$. In the second example, CV = 3% and PE = 5%, so Q = .360 and n = 4 is the first n such that $n/t^2 \geq Q$.

SAMPLE SIZE TABLES FOR SIMPLE RANDOM SAMPLING

Using this corrected iteration scheme, four sample size tables have been constructed for simple random sampling.[7] Tables 4-7 express sample sizes (n) required for estimated coefficients of variation (CV) to ensure prescribed allowable percentage sampling errors (PE) at varying levels of confidence. Four levels of confidence have been chosen: 99% confidence (Table 4), 95% confidence (Table 5), 90% confidence (Table 6), and 80% confidence (Table 7). The coefficients of variation range from 1% to 150% (except for the 99% confidence level table where the sample sizes become so large with high CV's as to become meaningless; hence we only consider CV's up to 100%). The percentage sampling errors are: 1%, 3%, 5%, 10%, 15%, 20%, 25%, 50% and 100%.

To illustrate the use of these tables, suppose a confidence level of 95% is required (see Table 5). If the coefficient of variation is estimated to be 20% (this value could be estimated from previous experience with "similar" populations or from a pilot survey), sample sizes of 174, 64, and 18 would be required to ensure prescribed allowable percentage sampling errors of 3%,

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[7] These tables have been generated using computer programs which have been developed to construct sample size tables for specified levels of confidence and ranges of PE's and CV's. The construction of additional tables of this type for other levels of confidence and ranges of PE's and CV's can be arranged by contacting the author.

5%, and 10%, respectively. If, however, the estimated coefficient of variation is 30%, sample sizes of 387, 141 and 38 would be required to maintain the same percentage sampling errors. Note how the required sample sizes increase as the CV's increase and the PE's decrease.

It may sometimes be appropriate to use the maximum of a range of possible CV's in the tables to determine sample size when the precision of the estimate for the CV is in doubt.[8] For instance, if the CV's are estimated to be between 30% and 40%, a sample size of n = 64 will ensure an allowable percentage sampling error of PE = 10% (n = 64 is the sample size required to ensure allowable percentage sampling error PE = 10% for the maximum CV = 40%). More rigorously, upper limits of one-sided confidence intervals for CV estimates may be used in the tables to determine sample size.

Linear interpolation may be used to give a rough approximation of sample sizes for intermediate percentage sampling error values not included in the table.[9] For instance, a CV = 15% and allowable PE = 12% requires an approximate sample size of n = 10 (interpolating between PE = 10% and PE = 15% using n = 12 and n = 7, respectively).

Percentage sampling errors can also be obtained from the table using coefficients of variation and sample sizes. For instance, a CV = 25% and n = 14 ensures a PE = 15%. Or, another example, a CV = 35% and n = 30 ensures an approximate PE = 14% (interpolating between n = 50 and n = 24 using PE = 10% and PE = 15%, respectively).

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[8]As indicated earlier, the algorithm used to construct these tables assumes precise estimates for the coefficients of variation (i.e., an estimate that is close to the true value).

[9]But, note, sample size is a decidedly nonlinear function of percentage sampling error. In fact, sample size is an inverse square function of percentage sampling error (cf. formula (10)).

For a fixed coefficient of variation, the percentage sampling errors decrease asymptotically as the sample sizes increase. Thus, a law of diminishing returns applies: continued increases in sample size result in diminishing improvements in precision (i.e., decreases in sampling error). Hence sampling intensity levels can be chosen which offer an "optimum" marginal improvement in precision per increase in sample size. For example, if CV = 25%, doubling the sample size from n = 14 to n = 28 decreases the percentage sampling error from PE = 15% to approximately PE = 10%. Adding another 14 samples, however, only reduces the percentage sampling error to approximately PE = 9%. Cost and time constraints on sampling intensity might then suggest using a sample size of n = 28 to ensure a percentage sampling error of PE = 10%, thus employing an "optimal" design in the sense of realizing the "best" possible improvement in precision per increase in sample size.

SAMPLE SIZE TABLES FOR DENSITY SAMPLING USING FIXED-AREA PLOTS

Consider now the case where fixed-area sample plots (quadrats) are being randomly positioned to provide estimates of density (e.g., tree density). The n sample measurements $x_1, x_2, \ldots, x_n$ then are the counts of the number of population members inside each of the sampled quadrats.

An estimate of density (per quadrat) is given by the mean ($\bar{x}$) of these sampled quadrat counts. The $(1-\alpha)\cdot 100\%$ confidence interval estimate is given by $[\bar{x}-E, \bar{x}+E]$ where $E=t_{n-1,\,\alpha/2}\cdot s/\sqrt{n}$ is the sampling error. Point and confidence interval estimates for the density per hectare and population totals are then given by $a\bar{x}$ and $[a\bar{x}-aE, a\bar{x}+aE]$, respectively, where a is the appropriate scaling factor (a = (area per hectare)/(area per quadrat) for density per hectare; a = (total area)/(area per quadrat) for population totals).

An estimate of spacing can also be obtained from this type of sampling by using the sampled variance/mean ratio ($s^2/\bar{x}$). The use of this ratio as an indicator of spatial distribution (i.e., index of nonrandomness) is well-known in the quantitative ecology literature (David and Moore 1954, Lloyd 1967, Morisita 1959, Pielou 1969). If the spacing is random, the spatial distribution is described by a Poisson distribution which has a variance equal to its mean; hence the variance/mean ratio equals 1. If the spacing is regular, the variance is less than the mean and the variance/mean ratio is less than 1. The binomial distribution is sometimes used to describe regular spacing. Conversely, if the spacing is aggregated (clumped), the variance is greater than the mean and the variance/mean ratio is greater than 1. The negative binomial distribution is sometimes used to describe aggregated spacing.

When density is being estimated using quadrat sampling, (10) can be adjusted by expressing the squared coefficient of variation as the product of the variance/mean ratio and the reciprocal of the mean.

$$CV^2 = ((s/\bar{x})\cdot 100\%)^2 = (s^2/\bar{x})\cdot(1/\bar{x})\cdot(100\%)^2 \ . \qquad (13)$$

Thus the coefficient of variation can be expressed as a function of two components, the variance/mean ratio ($s^2/\bar{x}$) and the mean ($\bar{x}$). Sample size tables for density estimation can hence be constructed using estimates for spacing and density rather than coefficients of variation.[10]

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[10]This may seem like a circular argument to use estimates of density to provide sampling guidelines for estimating density. However, it is really just a minimum of the estimate of density which is required in order to use the table. Hence the minimum of a range of densities or a lower limit of a one-sided confidence interval for a projected estimate of density will suffice.

Tables 8-11 list sample size tables for density sampling. These tables express sample size as a function of estimates of density ($\bar{x}$) and spacing ($s^2/\bar{x}$) and prescribed allowable sampling error (PE) at varying levels of confidence: 99% (Table 8), 95% (Table 9), 90% (Table 10) and 80% (Table 11). Three types of spacing have been included: regular spacing ($s^2/\bar{x}$ = .042), random spacing ($s^2/\bar{x}$ = 1.0), and aggregated spacing ($s^2/\bar{x}$ = 3.0). The regular spacing variance/mean ratio value corresponds to that produced by regular (square) 2.5 meter spacing sampled with 50 square meter quadrats (radius = 3.99 meters). The aggregated spacing variance/mean ratio value corresponds to that produced by a randomly spaced stand treated with strip or cross-hatch thinning (2.5 meter strips) and sampled with 50 square meter quadrats. The density levels correspond to the following types of regular (square) spacing:

(i) 625 stems/hectare = 4.0 meter (square spacing);
(ii) 816 stems/hectare = 3.5 meter (square spacing);
(iii) 1111 stems/hectare = 3.0 meter (square spacing);
(iv) 1600 stems/hectare = 2.5 meter (square spacing);
(v) 2500 stems/hectare = 2.0 meter (square spacing);
(vi) 4444 stems/hectare = 1.5 meter (square spacing);
(vii) 10000 stems/hectare = 1.0 meter (square spacing).

Percentage sampling errors of 1%, 3%, 5%, 10%, 25%, and 50% have been included in the tables. Quadrat sizes of 10, 20, 30, 40, 50, 100, 150, 200, and 300 square meters have also been included.

To illustrate the use of these tables, refer to Table 9e which lists sample sizes for 50 square meter quadrats at a 95% confidence level. In this situation, sampling in a natural stand (assumed randomly spaced) with estimated density of 1600 stems per hectare requires 536, 195 and 51 samples

to ensure prescribed percentage sampling errors of 3%, 5%, and 10%, respectively. If, however, the stand is a plantation (assumed regularly spaced), only 25, 11, and 5 samples are required to ensure the same percentage sampling errors. Note how the required sample sizes increase as the density decreases or as the spacing changes from regular to random to aggregated.

As before, linear interpolation can be used to approximate sample sizes for intermediate sampling errors. Sampling error can also be estimated using these tables by referring to the appropriate confidence level, quadrat size, density estimate, spacing estimate, and sample size.

It should be noted that these tables can also be used to provide guidelines for choosing an "optimal" quadrat size for density sampling. This can be determined by comparing the sampling intensities (i.e., percentage area sampled) required for different quadrat sizes to ensure a prescribed percentage sampling error for given estimates of density and spacing. Note that the estimates of spacing, given by the variance/mean ratio, will vary with the size of the quadrat and should be examined using either computer simulation or pilot sampling in the field.[11]

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[11] A computer program, SAMPLE, has been developed which simulates quadrat sampling on a prescribed spatial pattern of trees. For more details about this simulator or about quadrat sampling in general, see: Stauffer, H.B. 1982. The use of quadrat sampling to estimate tree density and spacing (unpublished notes). B.C. Ministry of Forests, Victoria, B.C.

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Table 1. Examples of convergence, using the classical iterative algorithm to calculate sample size (95% confidence level). Note:

CV = estimated coefficient of variation,

PE = allowable percentage sampling error,

$Q = CV^2/PE^2$,

I = iteration number,

n_I = sample size calculated at the Ith iteration,

t_m = t value with m degrees of freedom (2.5% probability),

n = sample size.

---

a) Convergence: CV = 20%, PE = 10%, Q = 4.000, n = 18

I	n_I	t_{n_I-1}	n_{I+1}
0	30	2.045	16.731
1	17	2.120	17.976
2	18	2.110	17.805
3	18		

b) Convergence: CV = 14%, PE = 3%, Q = 21.778, n = 87

I	n_I	t_{n_I-1}	n_{I+1}
0	30	2.045	91.094
1	92	1.986	85.927
2	86	1.988	86.090
3	87	1.988	86.061
4	87		

Table 2. Examples of divergence, using the classical iterative algorithm to calculate sample size (95% confidence level). Note:

CV = estimated coefficient of variation,

PE = allowable percentage sampling error,

$Q = CV^2/PE^2$,

I = iteration number,

n_I = sample size calculated at the Ith iteration,

t_m = t value with m degrees of freedom (2.5% probability),

n = sample size.

---

a) Divergence: CV = 8%, PE = 10%, Q = 0.640

I	n_I	t_{n_I-1}	n_{I+1}
0	30	2.045	2.677
1	3	4.303	11.850
2	12	2.201	3.100
3	4	3.182	6.480
4	7	2.447	3.831
5	4		

b) Divergence: CV = 3%, PE = 5%, Q = 0.360

I	n_I	t_{n_I-1}	n_{I+1}
0	30	2.045	1.506
1	2	12.706	58.119
2	59	2.002	1.442
3	2		

Table 3. Examples from Table 2, using the corrected iteration scheme to calculate sample size (95% confidence level). Note:

CV = estimated coefficient of variation,

PE = allowable percentage sampling error,

Q = CV^2/PE^2,

t_m = t value with m degrees of freedom (2.5% probability),

n = sample size.

n	n/t^2_{n-1}
2	0.012
3	0.162
4	0.395
5	0.649
6	0.908
7	1.169
8	1.431
9	1.693
10	1.954
11	2.216
12	2.477
13	2.739
14	3.000
15	3.261
16	3.522
17	3.783
18	4.044
19	4.305
20	4.566

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a) CV = 8%, PE = 10%, Q = 0.640: n = 5

b) CV = 3%, PE = 5%, Q = 0.360: n = 4

Table 4. Sample size table (99% confidence): sample sizes (n) required for estimated coefficients of variation (CV) to ensure prescribed allowable percentage sampling errors (PE).

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
1%	11	4	4	3	3	3	3	2	2
2%	31	7	5	4	3	3	3	3	2
3%	64	11	6	4	4	3	3	3	3
4%	111	16	8	5	4	4	3	3	3
5%	170	23	11	6	4	4	4	3	3
6%	243	31	14	6	5	4	4	3	3
7%	330	40	17	7	5	5	4	3	3
8%	429	52	21	8	6	5	4	3	3
9%	542	64	26	10	6	5	5	3	3
10%	668	78	31	11	7	6	5	4	3
11%	807	94	36	12	8	6	5	4	3
12%	960	111	43	14	8	6	5	4	3
13%	1126	129	49	15	9	7	6	4	3
14%	1305	149	56	17	10	7	6	4	3
15%	1498	170	64	19	11	8	6	4	3
16%	1703	193	72	21	12	8	7	4	3
17%	1922	217	81	23	13	9	7	4	3
18%	2155	243	90	26	14	10	8	5	3
19%	2400	271	100	28	15	10	8	5	4
20%	2659	299	111	31	16	11	8	5	4
21%	2931	330	121	34	17	12	9	5	4
22%	3217	361	133	36	19	12	9	5	4
23%	3515	394	145	39	20	13	10	5	4
24%	3827	429	157	43	21	14	10	5	4
25%	4152	465	170	46	23	15	11	6	4
26%	4491	503	184	49	24	15	11	6	4
27%	4843	542	198	53	26	16	12	6	4
28%	5208	582	212	56	27	17	13	6	4
29%	5586	625	228	60	29	18	13	6	4
30%	5978	668	243	64	31	19	14	6	4
31%	6382	713	259	68	33	20	14	7	4
32%	6801	759	276	72	35	21	15	7	4
33%	7232	807	293	77	36	22	16	7	4
34%	7677	857	311	81	38	23	17	7	4
35%	8135	908	330	86	40	25	17	7	5
36%	8606	960	348	90	43	26	18	8	5
37%	9090	1014	368	95	45	27	19	8	5
38%	9588	1069	388	100	47	28	20	8	5
39%	10099	1126	408	105	49	30	20	8	5
40%	10624	1184	429	111	52	31	21	8	5
41%	11161	1244	451	116	54	32	22	9	5
42%	11712	1305	473	121	56	34	23	9	5
43%	12276	1368	495	127	59	35	24	9	5
44%	12854	1432	518	133	61	36	25	9	5
45%	13444	1498	542	139	64	38	26	10	5
46%	14048	1565	566	145	67	39	27	10	5
47%	14665	1633	591	151	69	41	28	10	5
48%	15296	1703	616	157	72	43	29	10	5
49%	15940	1775	642	164	75	44	30	11	6
50%	16597	1848	668	170	78	46	31	11	6
51%	17267	1922	695	177	81	47	32	11	6
52%	17951	1998	722	184	84	49	33	11	6
53%	18648	2076	750	191	87	51	34	12	6

Table 4 continued ...

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
****	*****	*****	*****	******	******	******	******	******	*******
54%	19358	2155	778	198	90	53	35	12	6
55%	20081	2235	807	205	94	55	36	12	6
56%	20818	2317	837	212	97	56	38	13	6
57%	21568	2400	867	220	100	58	39	13	6
58%	22331	2485	897	228	104	60	40	13	6
59%	23108	2571	928	235	107	62	41	13	6
60%	23897	2659	960	243	111	64	43	14	6
61%	24701	2748	992	251	114	66	44	14	7
62%	25517	2839	1025	259	118	68	45	14	7
63%	26347	2931	1058	268	121	70	46	15	7
64%	27189	3025	1092	276	125	72	48	15	7
65%	28046	3120	1126	285	129	74	49	15	7
66%	28915	3217	1161	293	133	77	51	16	7
67%	29798	3315	1196	302	137	79	52	16	7
68%	30694	3414	1232	311	141	81	53	17	7
69%	31603	3515	1268	320	145	83	55	17	7
70%	32526	3618	1305	330	149	86	56	17	7
71%	33461	3722	1343	339	153	88	58	18	7
72%	34410	3827	1381	348	157	90	59	18	8
73%	35373	3934	1419	358	162	93	61	18	8
74%	36348	4043	1458	368	166	95	62	19	8
75%	37337	4152	1498	378	170	98	64	19	8
76%	38340	4264	1538	388	175	100	66	20	8
77%	39355	4377	1578	398	179	103	67	20	8
78%	40384	4491	1619	408	184	105	69	20	8
79%	41426	4607	1661	419	188	108	71	21	8
80%	42481	4724	1703	429	193	111	72	21	8
81%	43550	4843	1746	440	198	113	74	22	9
82%	44631	4963	1789	451	203	116	76	22	9
83%	45727	5085	1833	462	208	119	77	23	9
84%	46835	5208	1878	473	212	121	79	23	9
85%	47957	5332	1922	484	217	124	81	23	9
86%	49092	5458	1968	495	222	127	83	24	9
87%	50240	5586	2014	507	228	130	85	24	9
88%	51401	5715	2060	518	233	133	87	25	9
89%	52576	5846	2107	530	238	136	88	25	9
90%	53764	5978	2155	542	243	139	90	26	10
91%	54965	6111	2203	554	249	142	92	26	10
92%	56180	6246	2251	566	254	145	94	27	10
93%	57408	6382	2300	578	259	148	96	27	10
94%	58649	6520	2350	591	265	151	98	28	10
95%	59903	6660	2400	603	271	154	100	28	10
96%	61171	6801	2451	616	276	157	102	29	10
97%	62452	6943	2502	629	282	160	104	29	10
98%	63746	7087	2554	642	288	164	106	30	11
99%	65053	7232	2606	655	293	167	108	30	11
100%	66374	7379	2659	668	299	170	111	31	11

Table 5. Sample size table (95% confidence): sample sizes (n) required for estimated coefficients of variation (CV) to ensure prescribed allowable percentage sampling errors (PE).

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
1%	7	3	3	2	2	2	2	2	2
2%	18	5	3	3	3	2	2	2	2
3%	38	7	4	3	3	3	3	2	2
4%	64	10	5	3	3	3	3	2	2
5%	99	14	7	4	3	3	3	2	2
6%	141	18	9	4	3	3	3	3	2
7%	191	24	11	5	4	3	3	3	2
8%	249	30	13	5	4	3	3	3	2
9%	314	38	15	6	4	4	3	3	2
10%	387	46	18	7	5	4	3	3	2
11%	468	55	22	8	5	4	4	3	2
12%	556	64	25	9	5	4	4	3	3
13%	652	75	29	9	6	5	4	3	3
14%	756	87	33	11	6	5	4	3	3
15%	867	99	38	12	7	5	4	3	3
16%	986	112	42	13	7	5	5	3	3
17%	1113	126	47	14	8	6	5	3	3
18%	1248	141	53	15	9	6	5	3	3
19%	1390	157	58	17	9	6	5	3	3
20%	1539	174	64	18	10	7	5	3	3
21%	1697	191	71	20	11	7	6	4	3
22%	1862	210	77	22	11	8	6	4	3
23%	2035	229	84	23	12	8	6	4	3
24%	2216	249	91	25	13	9	7	4	3
25%	2404	270	99	27	14	9	7	4	3
26%	2600	291	107	29	15	9	7	4	3
27%	2803	314	115	31	15	10	7	4	3
28%	3015	338	123	33	16	11	8	4	3
29%	3234	362	132	35	17	11	8	4	3
30%	3460	387	141	38	18	12	9	4	3
31%	3694	413	151	40	19	12	9	4	3
32%	3936	440	160	42	20	13	9	5	3
33%	4186	468	170	45	22	13	10	5	3
34%	4444	496	181	47	23	14	10	5	3
35%	4709	526	191	50	24	15	11	5	3
36%	4981	556	202	53	25	15	11	5	3
37%	5262	587	213	56	26	16	11	5	3
38%	5550	619	225	58	28	17	12	5	3
39%	5846	652	237	61	29	18	12	5	3
40%	6149	686	249	64	30	18	13	5	3
41%	6460	720	261	68	32	19	13	6	4
42%	6779	756	274	71	33	20	14	6	4
43%	7106	792	287	74	35	21	14	6	4
44%	7440	829	300	77	36	22	15	6	4
45%	7782	867	314	81	38	22	15	6	4
46%	8131	906	328	84	39	23	16	6	4
47%	8489	946	342	88	41	24	17	6	4
48%	8853	986	357	91	42	25	17	7	4
49%	9226	1028	372	95	44	26	18	7	4
50%	9606	1070	387	99	46	27	18	7	4
51%	9994	1113	403	103	47	28	19	7	4
52%	10390	1157	418	107	49	29	20	7	4
53%	10793	1202	435	111	51	30	20	7	4

Table 5 continued ...

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
54%	11204	1248	451	115	53	31	21	7	4
55%	11623	1294	468	119	55	32	22	8	4
56%	12050	1341	485	123	56	33	22	8	4
57%	12484	1390	502	128	58	34	23	8	4
58%	12925	1439	520	132	60	35	24	8	4
59%	13375	1489	538	137	62	36	24	8	4
60%	13832	1539	556	141	64	38	25	9	4
61%	14297	1591	575	146	66	39	26	9	4
62%	14769	1644	594	151	69	40	27	9	4
63%	15249	1697	613	155	71	41	27	9	5
64%	15737	1751	632	160	73	42	28	9	5
65%	16233	1806	652	165	75	44	29	9	5
66%	16736	1862	672	170	77	45	30	10	5
67%	17247	1919	693	175	80	46	31	10	5
68%	17765	1977	713	181	82	47	31	10	5
69%	18292	2035	734	186	84	49	32	10	5
70%	18826	2094	756	191	87	50	33	11	5
71%	19367	2155	777	197	89	51	34	11	5
72%	19917	2216	799	202	91	53	35	11	5
73%	20474	2277	822	208	94	54	36	11	5
74%	21038	2340	844	213	96	56	37	11	5
75%	21611	2404	867	219	99	57	38	12	5
76%	22191	2468	890	225	102	58	38	12	5
77%	22778	2534	914	231	104	60	39	12	5
78%	23374	2600	938	237	107	61	40	12	5
79%	23977	2667	962	243	109	63	41	13	5
80%	24588	2735	986	249	112	64	42	13	5
81%	25206	2803	1011	255	115	66	43	13	6
82%	25832	2873	1036	261	118	68	44	13	6
83%	26466	2943	1061	268	121	69	45	14	6
84%	27108	3015	1087	274	123	71	46	14	6
85%	27757	3087	1113	280	126	72	47	14	6
86%	28414	3160	1139	287	129	74	48	14	6
87%	29078	3234	1166	294	132	76	49	15	6
88%	29751	3308	1193	300	135	77	51	15	6
89%	30431	3384	1220	307	138	79	52	15	6
90%	31118	3460	1248	314	141	81	53	15	6
91%	31813	3537	1275	321	144	82	54	16	6
92%	32516	3616	1303	328	147	84	55	16	6
93%	33227	3694	1332	335	151	86	56	16	6
94%	33945	3774	1361	342	154	88	57	17	6
95%	34671	3855	1390	350	157	90	58	17	6
96%	35405	3936	1419	357	160	91	60	17	7
97%	36146	4019	1449	364	164	93	61	17	7
98%	36896	4102	1479	372	167	95	62	18	7
99%	37652	4186	1509	379	170	97	63	18	7
100%	38417	4271	1539	387	174	99	64	18	7
101%	39189	4357	1570	395	177	101	66	19	7
102%	39969	4444	1602	403	181	103	67	19	7
103%	40756	4531	1633	410	184	105	68	19	7
104%	41551	4619	1665	418	188	107	69	20	7
105%	42354	4709	1697	426	191	109	71	20	7
106%	43165	4799	1729	435	195	111	72	20	7
107%	43983	4890	1762	443	198	113	73	21	7
108%	44809	4981	1795	451	202	115	75	21	7

Table 5 continued ...

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
109%	45642	5074	1828	459	206	117	75	21	8
110%	46484	5167	1862	468	210	119	77	22	8
111%	47333	5262	1896	476	213	121	79	22	8
112%	48189	5357	1930	485	217	123	80	22	8
113%	49053	5453	1965	493	221	126	81	23	8
114%	49925	5550	2000	502	225	128	83	23	8
115%	50805	5648	2035	511	229	130	84	23	8
116%	51693	5746	2071	520	233	132	86	24	8
117%	52588	5846	2106	529	237	134	87	24	8
118%	53490	5946	2142	538	241	137	89	24	8
119%	54401	6047	2179	547	245	139	90	25	8
120%	55319	6149	2216	556	249	141	91	25	9
121%	56245	6252	2253	565	253	144	93	25	9
122%	57178	6356	2290	575	257	146	94	26	9
123%	58119	6460	2328	584	261	148	96	26	9
124%	59068	6566	2366	594	265	151	97	27	9
125%	60024	6672	2404	603	270	153	99	27	9
126%	60989	6779	2442	613	274	155	101	27	9
127%	61961	6887	2481	622	278	158	102	28	9
128%	62940	6996	2520	632	283	160	104	28	9
129%	63927	7106	2560	642	287	163	105	29	9
130%	64922	7216	2600	652	291	165	107	29	9
131%	65925	7328	2640	662	296	168	108	29	10
132%	66935	7440	2680	672	300	170	110	30	10
133%	67953	7553	2721	682	305	173	112	30	10
134%	68979	7667	2762	693	309	175	113	31	10
135%	70012	7782	2803	703	314	178	115	31	10
136%	71053	7897	2845	713	319	181	117	31	10
137%	72102	8014	2887	724	323	183	118	32	10
138%	73158	8131	2929	734	328	186	120	32	10
139%	74222	8250	2972	745	333	188	122	33	10
140%	75294	8369	3015	756	338	191	123	33	11
141%	76373	8489	3058	767	342	194	125	33	11
142%	77461	8609	3101	777	347	197	127	34	11
143%	78555	8731	3145	788	352	199	129	34	11
144%	79658	8853	3189	799	357	202	130	35	11
145%	80768	8977	3234	811	362	205	132	35	11
146%	81886	9101	3278	822	367	208	134	36	11
147%	83011	9226	3323	833	372	210	136	36	11
148%	84145	9352	3369	844	377	213	138	37	11
149%	85285	9479	3414	856	382	216	139	37	12
150%	86434	9606	3460	867	387	219	141	38	12

Table 6. Sample size table (90% confidence): sample sizes (n) required for estimated coefficients of variation (CV) to ensure prescribed allowable percentage sampling errors (PE).

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
1%	5	3	2	2	2	2	2	2	2
2%	13	4	3	2	2	2	2	2	2
3%	27	5	4	3	2	2	2	2	2
4%	46	7	4	3	3	2	2	2	2
5%	70	10	5	3	3	3	2	2	2
6%	100	13	6	4	3	3	3	2	2
7%	135	17	8	4	3	3	3	2	2
8%	176	22	9	4	3	3	3	2	2
9%	221	27	11	5	4	3	3	2	2
10%	273	32	13	5	4	3	3	2	2
11%	330	39	16	6	4	3	3	2	2
12%	392	46	18	6	4	4	3	3	2
13%	460	53	21	7	5	4	3	3	2
14%	533	61	24	8	5	4	3	3	2
15%	611	70	27	9	5	4	4	3	2
16%	695	79	30	9	6	4	4	3	2
17%	784	89	34	10	6	4	4	3	2
18%	879	100	37	11	6	5	4	3	2
19%	979	111	41	12	7	5	4	3	2
20%	1085	123	46	13	7	5	4	3	2
21%	1195	135	50	14	8	6	4	3	2
22%	1312	148	55	16	8	6	5	3	2
23%	1434	161	60	17	9	6	5	3	3
24%	1561	176	65	18	9	6	5	3	3
25%	1693	190	70	19	10	7	5	3	3
26%	1831	206	76	21	11	7	5	3	3
27%	1975	221	81	22	11	7	6	3	3
28%	2123	238	87	24	12	8	6	3	3
29%	2278	255	93	25	13	8	6	3	3
30%	2437	273	100	27	13	9	6	4	3
31%	2602	291	106	28	14	9	7	4	3
32%	2773	310	113	30	15	9	7	4	3
33%	2949	330	120	32	16	10	7	4	3
34%	3130	350	127	34	16	10	7	4	3
35%	3317	371	135	36	17	11	8	4	3
36%	3509	392	143	37	18	11	8	4	3
37%	3706	414	151	39	19	12	8	4	3
38%	3909	436	159	41	20	12	9	4	3
39%	4117	460	167	44	21	13	9	4	3
40%	4331	483	176	46	22	13	9	4	3
41%	4550	508	184	48	23	14	10	4	3
42%	4775	533	193	50	24	14	10	4	3
43%	5005	558	202	52	25	15	10	5	3
44%	5240	584	212	55	26	16	11	5	3
45%	5481	611	221	57	27	16	11	5	3
46%	5727	638	231	60	28	17	12	5	3
47%	5979	666	241	62	29	17	12	5	3
48%	6236	695	252	65	30	18	12	5	3
49%	6498	724	262	67	31	19	13	5	3
50%	6766	754	273	70	32	19	13	5	3
51%	7039	784	284	73	34	20	14	5	3
52%	7318	815	295	76	35	21	14	5	3
53%	7602	847	306	78	36	21	15	6	3

Table 6 continued ...

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
54%	7891	879	318	81	37	22	15	6	3
55%	8186	912	330	84	39	23	16	6	3
56%	8487	945	342	87	40	24	16	6	3
57%	8792	979	354	90	41	24	16	6	3
58%	9103	1014	366	93	43	25	17	6	3
59%	9420	1049	379	97	44	26	17	6	3
60%	9742	1085	392	100	46	27	18	6	4
61%	10069	1121	405	103	47	28	19	7	4
62%	10402	1158	418	106	49	28	19	7	4
63%	10740	1195	432	110	50	29	20	7	4
64%	11084	1234	446	113	52	30	20	7	4
65%	11433	1272	460	117	53	31	21	7	4
66%	11787	1312	474	120	55	32	21	7	4
67%	12147	1352	488	124	56	33	22	7	4
68%	12512	1392	503	127	58	34	22	7	4
69%	12883	1434	518	131	60	35	23	8	4
70%	13259	1475	533	135	61	36	24	8	4
71%	13641	1518	548	139	63	36	24	8	4
72%	14027	1561	563	143	65	37	25	8	4
73%	14420	1604	579	147	66	38	25	8	4
74%	14817	1648	595	151	68	39	26	8	4
75%	15221	1693	611	155	70	40	27	9	4
76%	15629	1739	627	159	72	41	27	9	4
77%	16043	1785	644	163	74	42	28	9	4
78%	16462	1831	661	167	76	44	29	9	4
79%	16887	1878	678	171	77	45	29	9	4
80%	17317	1926	695	176	79	46	30	9	4
81%	17753	1975	712	180	81	47	31	10	4
82%	18194	2024	730	184	83	48	31	10	4
83%	18640	2073	748	189	85	49	32	10	4
84%	19092	2123	766	193	87	50	33	10	4
85%	19549	2174	784	198	89	51	34	10	4
86%	20012	2226	803	202	91	52	34	10	5
87%	20480	2278	821	207	93	54	35	11	5
88%	20953	2330	840	212	95	55	36	11	5
89%	21432	2383	860	217	98	56	37	11	5
90%	21917	2437	879	221	100	57	37	11	5
91%	22406	2492	899	226	102	58	38	11	5
92%	22901	2547	918	231	104	60	39	12	5
93%	23402	2602	938	236	106	61	40	12	5
94%	23908	2659	959	241	109	62	41	12	5
95%	24419	2715	979	247	111	63	41	12	5
96%	24936	2773	1000	252	113	65	42	12	5
97%	25458	2831	1021	257	115	66	43	13	5
98%	25986	2889	1042	262	118	67	44	13	5
99%	26519	2949	1063	268	120	69	45	13	5
100%	27057	3008	1085	273	123	70	46	13	5
101%	27601	3069	1106	278	125	71	47	13	5
102%	28150	3130	1128	284	127	73	47	14	5
103%	28704	3191	1150	289	130	74	48	14	5
104%	29264	3254	1173	295	132	76	49	14	5
105%	29830	3317	1195	301	135	77	50	14	6
106%	30401	3380	1218	306	137	78	51	15	6
107%	30977	3444	1241	312	140	80	52	15	6
108%	31559	3509	1265	318	143	81	53	15	6

Table 6 continued ...

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
109%	32146	3574	1288	324	145	83	54	15	6
110%	32738	3640	1312	330	148	84	55	16	6
111%	33336	3706	1336	336	151	86	56	16	6
112%	33940	3773	1360	342	153	87	57	16	6
113%	34548	3841	1384	348	156	89	58	16	6
114%	35162	3909	1409	354	159	90	59	16	6
115%	35782	3978	1434	360	161	92	60	17	6
116%	36407	4047	1459	366	164	93	61	17	6
117%	37037	4117	1484	373	167	95	62	17	6
118%	37673	4188	1509	379	170	97	63	17	6
119%	38314	4259	1535	385	173	98	64	18	6
120%	38961	4331	1561	392	176	100	65	18	6
121%	39613	4404	1587	398	178	101	66	18	6
122%	40270	4477	1613	405	181	103	67	19	7
123%	40933	4550	1640	412	184	105	68	19	7
124%	41601	4624	1666	418	187	106	69	19	7
125%	42275	4699	1693	425	190	108	70	19	7
126%	42954	4775	1720	432	193	110	71	20	7
127%	43639	4851	1748	439	196	111	72	20	7
128%	44329	4927	1775	446	199	113	73	20	7
129%	45024	5005	1803	453	202	115	74	20	7
130%	45724	5083	1831	460	206	117	76	21	7
131%	46431	5161	1859	467	209	118	77	21	7
132%	47142	5240	1888	474	212	120	78	21	7
133%	47859	5320	1917	481	215	122	79	22	7
134%	48581	5400	1946	488	218	124	80	22	7
135%	49309	5481	1975	495	221	126	81	22	7
136%	50042	5562	2004	503	225	127	82	22	7
137%	50781	5644	2033	510	228	129	84	23	8
138%	51525	5727	2063	518	231	131	85	23	8
139%	52274	5810	2093	525	235	133	86	23	8
140%	53029	5894	2123	533	238	135	87	24	8
141%	53789	5979	2154	540	241	137	88	24	8
142%	54555	6064	2184	548	245	139	90	24	8
143%	55326	6149	2215	556	248	141	91	25	8
144%	56103	6236	2246	563	252	143	92	25	8
145%	56884	6323	2278	571	255	145	93	25	8
146%	57672	6410	2309	579	259	147	95	25	8
147%	58464	6498	2341	587	262	149	96	26	8
148%	59263	6587	2373	595	266	151	97	26	8
149%	60066	6676	2405	603	269	153	98	26	8
150%	60875	6766	2437	611	273	155	100	27	9

Table 7. Sample size table (80% confidence): sample sizes (n) required for estimated coefficients of variation (CV) to ensure prescribed allowable percentage sampling errors (PE).

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
1%	4	2	2	2	2	2	2	2	2
2%	9	3	2	2	2	2	2	2	2
3%	17	4	3	2	2	2	2	2	2
4%	28	5	3	2	2	2	2	2	2
5%	43	7	4	3	2	2	2	2	2
6%	61	9	4	3	2	2	2	2	2
7%	82	11	5	3	3	2	2	2	2
8%	107	14	6	3	3	2	2	2	2
9%	135	17	7	3	3	2	2	2	2
10%	166	20	9	4	3	3	2	2	2
11%	201	24	10	4	3	3	2	2	2
12%	238	28	11	4	3	3	3	2	2
13%	279	33	13	5	3	3	3	2	2
14%	324	38	15	5	4	3	3	2	2
15%	371	43	17	6	4	3	3	2	2
16%	422	49	19	6	4	3	3	2	2
17%	476	55	21	7	4	3	3	2	2
18%	534	61	23	7	4	3	3	2	2
19%	595	68	26	8	5	4	3	2	2
20%	659	75	28	9	5	4	3	2	2
21%	726	82	31	9	5	4	3	2	2
22%	797	90	34	10	6	4	3	2	2
23%	871	98	37	11	6	4	4	3	2
24%	948	107	40	11	6	4	4	3	2
25%	1028	116	43	12	7	5	4	3	2
26%	1112	125	46	13	7	5	4	3	2
27%	1199	135	50	14	7	5	4	3	2
28%	1289	145	53	15	8	5	4	3	2
29%	1383	155	57	16	8	5	4	3	2
30%	1480	166	61	17	9	6	4	3	2
31%	1580	177	65	18	9	6	5	3	2
32%	1684	189	69	19	9	6	5	3	2
33%	1790	201	73	20	10	6	5	3	2
34%	1900	213	78	21	10	7	5	3	2
35%	2014	225	82	22	11	7	5	3	2
36%	2130	238	87	23	11	7	5	3	2
37%	2250	252	92	24	12	8	6	3	2
38%	2373	265	97	26	12	8	6	3	2
39%	2500	279	102	27	13	8	6	3	2
40%	2630	294	107	28	14	9	6	3	2
41%	2763	309	112	29	14	9	6	3	2
42%	2899	324	118	31	15	9	7	3	2
43%	3039	339	123	32	15	10	7	3	2
44%	3181	355	129	34	16	10	7	3	2
45%	3328	371	135	35	17	10	7	3	2
46%	3477	388	141	37	17	11	8	4	3
47%	3630	405	147	38	18	11	8	4	3
48%	3786	422	153	40	19	11	8	4	3
49%	3945	440	160	41	19	12	8	4	3
50%	4108	458	166	43	20	12	9	4	3
51%	4274	476	173	45	21	13	9	4	3
52%	4443	495	179	46	22	13	9	4	3
53%	4615	514	186	48	22	13	9	4	3

Table 7 continued ...

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
****	*****	*****	*****	******	******	******	******	******	*******
54%	4791	534	193	50	23	14	10	4	3
55%	4970	554	201	52	24	14	10	4	3
56%	5152	574	208	53	25	15	10	4	3
57%	5338	595	215	55	26	15	10	4	3
58%	5527	616	223	57	26	16	11	4	3
59%	5719	637	231	59	27	16	11	4	3
60%	5914	659	238	61	28	17	11	4	3
61%	6113	681	246	63	29	17	12	4	3
62%	6315	703	254	65	30	18	12	5	3
63%	6520	726	263	67	31	18	12	5	3
64%	6729	749	271	69	32	19	13	5	3
65%	6941	773	279	71	33	19	13	5	3
66%	7156	797	288	73	34	20	13	5	3
67%	7374	821	297	76	35	20	14	5	3
68%	7596	846	306	78	36	21	14	5	3
69%	7821	871	315	80	37	21	14	5	3
70%	8049	896	324	82	38	22	15	5	3
71%	8281	922	333	85	39	23	15	5	3
72%	8516	948	342	87	40	23	16	5	3
73%	8754	974	352	89	41	24	16	6	3
74%	8996	1001	362	92	42	24	16	6	3
75%	9240	1028	371	94	43	25	17	6	3
76%	9488	1056	381	97	44	26	17	6	3
77%	9740	1084	391	99	45	26	17	6	3
78%	9994	1112	402	102	46	27	18	6	3
79%	10252	1141	412	104	47	27	18	6	3
80%	10513	1170	422	107	49	28	19	6	3
81%	10777	1199	433	110	50	29	19	6	3
82%	11045	1229	444	112	51	29	20	6	3
83%	11316	1259	454	115	52	30	20	7	3
84%	11590	1289	465	118	53	31	20	7	3
85%	11868	1320	476	120	55	32	21	7	3
86%	12149	1351	488	123	56	32	21	7	3
87%	12433	1383	499	126	57	33	22	7	3
88%	12720	1415	511	129	58	34	22	7	3
89%	13011	1447	522	132	60	34	23	7	3
90%	13305	1480	534	135	61	35	23	7	3
91%	13602	1513	546	138	62	36	24	7	3
92%	13903	1546	558	141	64	37	24	8	4
93%	14207	1580	570	144	65	37	25	8	4
94%	14514	1614	582	147	66	38	25	8	4
95%	14824	1649	595	150	68	39	26	8	4
96%	15138	1684	607	153	69	40	26	8	4
97%	15455	1719	620	156	71	40	27	8	4
98%	15775	1754	633	160	72	41	27	8	4
99%	16099	1790	646	163	73	42	28	8	4
100%	16426	1827	659	166	75	43	28	9	4
101%	16756	1863	672	169	76	44	29	9	4
102%	17089	1900	685	173	78	45	29	9	4
103%	17426	1938	699	176	79	45	30	9	4
104%	17766	1976	712	179	81	46	30	9	4
105%	18109	2014	726	183	82	47	31	9	4
106%	18456	2052	740	186	84	48	31	9	4
107%	18805	2091	754	190	85	49	32	9	4
108%	19159	2130	768	193	87	50	33	10	4

Table 7 continued ...

CV	n: PE=1%	n: PE=3%	n: PE=5%	n: PE=10%	n: PE=15%	n: PE=20%	n: PE=25%	n: PE=50%	n: PE=100%
****	*****	*****	*****	******	******	******	******	******	*******
109%	19515	2170	782	197	89	51	33	10	4
110%	19875	2210	797	201	90	52	34	10	4
111%	20238	2250	811	204	92	52	34	10	4
112%	20604	2291	826	208	93	53	35	10	4
113%	20973	2332	841	212	95	54	35	10	4
114%	21346	2373	856	215	97	55	36	10	4
115%	21722	2415	871	219	98	56	37	11	4
116%	22102	2457	886	223	100	57	37	11	4
117%	22484	2500	901	227	102	58	38	11	4
118%	22870	2543	917	231	103	59	38	11	4
119%	23260	2586	932	234	105	60	39	11	4
120%	23652	2630	948	238	107	61	40	11	4
121%	24048	2674	964	242	109	62	40	12	4
122%	24447	2718	980	246	110	63	41	12	4
123%	24849	2763	996	250	112	64	42	12	5
124%	25255	2808	1012	254	114	65	42	12	5
125%	25664	2853	1028	258	116	66	43	12	5
126%	26076	2899	1045	263	118	67	44	12	5
127%	26492	2945	1061	267	120	68	44	12	5
128%	26911	2992	1078	271	121	69	45	13	5
129%	27333	3039	1095	275	123	70	46	13	5
130%	27758	3086	1112	279	125	71	46	13	5
131%	28187	3133	1129	284	127	72	47	13	5
132%	28619	3181	1146	288	129	73	48	13	5
133%	29054	3230	1164	292	131	74	48	14	5
134%	29492	3279	1181	297	133	76	49	14	5
135%	29934	3328	1199	301	135	77	50	14	5
136%	30379	3377	1217	306	137	78	50	14	5
137%	30828	3427	1235	310	139	79	51	14	5
138%	31279	3477	1253	315	141	80	52	14	5
139%	31734	3528	1271	319	143	81	53	15	5
140%	32192	3579	1289	324	145	82	53	15	5
141%	32654	3630	1308	328	147	83	54	15	5
142%	33119	3681	1326	333	149	85	55	15	5
143%	33587	3733	1345	338	151	86	56	15	5
144%	34058	3786	1364	342	153	87	56	16	5
145%	34533	3839	1383	347	155	88	57	16	5
146%	35011	3892	1402	352	157	89	58	16	6
147%	35492	3945	1421	357	160	91	59	16	6
148%	35977	3999	1441	362	162	92	59	16	6
149%	36464	4053	1460	366	164	93	60	16	6
150%	36955	4108	1480	371	166	94	61	17	6

Table 8. Sample size table for density sampling (99% confidence): sample sizes required for estimated stand densities (stems/hectare) and tree spatial patterns (V/m = variance/mean ratios) to ensure prescribed allowable percentage sampling errors (PE).

a) 10 square meter quadrats (1.78 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	4464	500	183	49	11	6
625	1.000	106195	11803	4252	1066	174	47
625	3.000	318578	35401	12747	3190	514	132
816	0.042	3420	384	141	38	10	5
816	1.000	81339	9042	3258	818	134	37
816	3.000	244010	27116	9765	2444	395	102
1111	0.042	2513	283	105	29	8	5
1111	1.000	59743	6642	2394	602	100	28
1111	3.000	179220	19917	7173	1796	291	76
1600	0.042	1747	198	74	22	7	4
1600	1.000	41485	4613	1664	419	71	21
1600	3.000	124447	13831	4982	1249	203	54
2500	0.042	1119	128	49	15	6	4
2500	1.000	26552	2954	1066	270	47	15
2500	3.000	79648	8854	3190	801	132	36
4444	0.042	632	74	29	10	5	4
4444	1.000	14939	1664	602	154	28	10
4444	3.000	44808	4983	1796	452	76	22
10000	0.042	283	35	15	7	4	3
10000	1.000	6641	742	270	71	15	7
10000	3.000	19915	2217	801	203	36	12

b) 20 square meter quadrats (2.52 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	2234	252	94	27	8	5
625	1.000	53100	5904	2128	535	89	26
625	3.000	159291	17703	6376	1597	259	68
816	0.042	1712	194	73	21	7	4
816	1.000	40672	4523	1631	411	69	21
816	3.000	122007	13560	4884	1224	200	53
1111	0.042	1259	144	54	17	6	4
1111	1.000	29874	3323	1199	303	52	16
1111	3.000	89612	9961	3589	900	148	40
1600	0.042	875	101	39	13	5	4
1600	1.000	20745	2309	834	212	37	13
1600	3.000	62226	6918	2493	627	104	29
2500	0.042	562	66	27	10	5	4
2500	1.000	13278	1479	535	137	26	10
2500	3.000	39826	4429	1597	403	68	20
4444	0.042	318	39	17	7	4	3
4444	1.000	7472	834	303	79	16	7
4444	3.000	22406	2493	900	228	40	13
10000	0.042	144	20	10	5	4	3
10000	1.000	3323	373	137	37	10	5
10000	3.000	9960	1110	403	104	20	8

Table 8 continued ...

c) 30 square meter quadrats (3.09 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	1491	170	64	19	6	4
625	1.000	35401	3937	1420	358	61	18
625	3.000	106195	11803	4252	1066	174	47
816	0.042	1143	131	50	16	6	4
816	1.000	27116	3017	1089	275	48	15
816	3.000	81339	9042	3258	818	134	37
1111	0.042	841	97	38	13	5	4
1111	1.000	19917	2217	801	203	36	12
1111	3.000	59743	6642	2394	602	100	28
1600	0.042	585	69	28	10	5	4
1600	1.000	13831	1541	557	143	26	10
1600	3.000	41485	4613	1664	419	71	21
2500	0.042	376	46	19	8	4	3
2500	1.000	8854	988	358	93	18	8
2500	3.000	26552	2954	1066	270	47	15
4444	0.042	213	28	13	6	4	3
4444	1.000	4983	557	203	54	12	6
4444	3.000	14939	1664	602	154	28	10
10000	0.042	97	15	8	5	3	3
10000	1.000	2217	250	93	26	8	5
10000	3.000	6641	742	270	71	15	7

d) 40 square meter quadrats (3.57 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	1119	128	49	15	6	4
625	1.000	26552	2954	1066	270	47	15
625	3.000	79648	8854	3190	801	132	36
816	0.042	858	99	38	13	5	4
816	1.000	20338	2264	818	208	37	12
816	3.000	61006	6782	2444	614	102	29
1111	0.042	632	74	29	10	5	4
1111	1.000	14939	1664	602	154	28	10
1111	3.000	44808	4983	1796	452	76	22
1600	0.042	440	53	22	9	4	3
1600	1.000	10375	1157	419	108	21	8
1600	3.000	31115	3461	1249	315	54	17
2500	0.042	283	35	15	7	4	3
2500	1.000	6641	742	270	71	15	7
2500	3.000	19915	2217	801	203	36	12
4444	0.042	161	22	10	5	4	3
4444	1.000	3738	419	154	42	10	5
4444	3.000	11205	1249	452	116	22	9
10000	0.042	74	12	7	4	3	3
10000	1.000	1664	189	71	21	7	4
10000	3.000	4982	557	203	54	12	6

Table 8 continued ...

e) 50 square meter quadrats (3.99 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	896	103	40	13	5	4
625	1.000	21243	2364	854	217	38	13
625	3.000	63719	7084	2553	641	106	30
816	0.042	688	80	32	11	5	4
816	1.000	16271	1812	655	167	30	11
816	3.000	48805	5427	1956	492	82	24
1111	0.042	506	60	24	9	5	3
1111	1.000	11952	1332	482	124	23	9
1111	3.000	35847	3987	1438	363	62	19
1600	0.042	353	43	18	8	4	3
1600	1.000	8301	926	336	87	18	7
1600	3.000	24893	2770	1000	253	44	14
2500	0.042	227	29	13	6	4	3
2500	1.000	5314	594	217	57	13	6
2500	3.000	15933	1774	641	164	30	11
4444	0.042	130	18	9	5	3	3
4444	1.000	2991	336	124	34	9	5
4444	3.000	8965	1000	363	94	19	8
10000	0.042	60	10	6	4	3	3
10000	1.000	1332	152	57	18	6	4
10000	3.000	3986	447	164	44	11	6

f) 100 square meter quadrats (5.64 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	450	54	22	9	4	3
625	1.000	10623	1184	429	111	21	8
625	3.000	31862	3544	1279	323	55	17
816	0.042	346	42	18	8	4	3
816	1.000	8138	908	330	86	17	7
816	3.000	24405	2715	980	248	43	14
1111	0.042	255	32	14	7	4	3
1111	1.000	5978	668	243	64	14	6
1111	3.000	17926	1996	721	184	33	11
1600	0.042	179	24	11	6	4	3
1600	1.000	4152	465	170	46	11	6
1600	3.000	12449	1387	502	129	24	9
2500	0.042	116	17	9	5	3	3
2500	1.000	2659	299	111	31	8	5
2500	3.000	7969	889	323	84	17	7
4444	0.042	67	11	7	4	3	3
4444	1.000	1498	170	64	19	6	4
4444	3.000	4485	502	184	49	11	6
10000	0.042	32	7	5	4	3	3
10000	1.000	668	78	31	11	5	4
10000	3.000	1995	226	84	24	7	5

Table 8 continued ...

g) 150 square meter quadrats (6.91 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	302	37	16	7	4	3
625	1.000	7084	791	287	75	16	7
625	3.000	21243	2364	854	217	38	13
816	0.042	232	30	13	6	4	3
816	1.000	5427	607	221	59	13	6
816	3.000	16271	1812	655	167	30	11
1111	0.042	172	23	11	6	4	3
1111	1.000	3987	447	164	44	11	6
1111	3.000	11952	1332	482	124	23	9
1600	0.042	120	17	9	5	3	3
1600	1.000	2770	312	115	32	9	5
1600	3.000	8301	926	336	87	18	7
2500	0.042	79	13	7	4	3	3
2500	1.000	1774	201	75	22	7	4
2500	3.000	5314	594	217	57	13	6
4444	0.042	46	9	6	4	3	3
4444	1.000	1000	115	44	14	6	4
4444	3.000	2991	336	124	34	9	5
10000	0.042	23	6	4	3	3	3
10000	1.000	447	53	22	9	4	3
10000	3.000	1332	152	57	18	6	4

h) 200 square meter quadrats (7.98 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	227	29	13	6	4	3
625	1.000	5314	594	217	57	13	6
625	3.000	15933	1774	641	164	30	11
816	0.042	175	23	11	6	4	3
816	1.000	4071	456	167	45	11	6
816	3.000	12205	1360	492	126	24	9
1111	0.042	130	18	9	5	3	3
1111	1.000	2991	336	124	34	9	5
1111	3.000	8965	1000	363	94	19	8
1600	0.042	91	14	8	5	3	3
1600	1.000	2078	235	87	25	7	5
1600	3.000	6226	696	253	67	14	7
2500	0.042	60	10	6	4	3	3
2500	1.000	1332	152	57	18	6	4
2500	3.000	3986	447	164	44	11	6
4444	0.042	36	8	5	4	3	3
4444	1.000	751	87	34	12	5	4
4444	3.000	2245	253	94	27	8	5
10000	0.042	18	5	4	3	3	3
10000	1.000	336	41	18	7	4	3
10000	3.000	1000	115	44	14	6	4

Table 8 continued ...

i) 300 square meter quadrats (9.77 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	153	21	10	5	4	3
625	1.000	3544	398	146	40	10	5
625	3.000	10623	1184	429	111	21	8
816	0.042	118	17	9	5	3	3
816	1.000	2715	306	113	31	9	5
816	3.000	8138	908	330	86	17	7
1111	0.042	88	14	7	5	3	3
1111	1.000	1996	226	84	24	7	5
1111	3.000	5978	668	243	64	14	6
1600	0.042	62	11	6	4	3	3
1600	1.000	1387	158	60	18	6	4
1600	3.000	4152	465	170	46	11	6
2500	0.042	41	8	5	4	3	3
2500	1.000	889	103	40	13	5	4
2500	3.000	2659	299	111	31	8	5
4444	0.042	25	6	5	3	3	3
4444	1.000	502	60	24	9	5	3
4444	3.000	1498	170	64	19	6	4
10000	0.042	14	5	4	3	3	3
10000	1.000	226	29	13	6	4	3
10000	3.000	668	78	31	11	5	4

Table 9. Sample size table for density sampling (95% confidence): sample sizes required for estimated stand densities (stems/hectare) and tree spatial patterns (V/m = variance/mean ratios) to ensure prescribed allowable percentage sampling errors (PE).

a) 10 square meter quadrats (1.78 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	2584	290	106	29	7	4
625	1.000	61465	6832	2461	618	101	28
625	3.000	184389	20490	7378	1847	298	77
816	0.042	1980	223	82	23	6	4
816	1.000	47079	5234	1886	474	78	22
816	3.000	141230	15695	5652	1415	229	59
1111	0.042	1455	164	61	17	5	3
1111	1.000	34579	3845	1386	349	58	17
1111	3.000	103731	11528	4152	1040	169	44
1600	0.042	1011	115	43	13	5	3
1600	1.000	24012	2671	963	243	41	13
1600	3.000	72029	8006	2884	723	118	32
2500	0.042	648	75	29	9	4	3
2500	1.000	15368	1710	618	157	28	9
2500	3.000	46099	5125	1847	464	77	21
4444	0.042	366	43	17	7	3	3
4444	1.000	8647	963	349	89	17	6
4444	3.000	25935	2884	1040	262	44	13
10000	0.042	164	21	9	5	3	3
10000	1.000	3844	430	157	41	9	5
10000	3.000	11527	1283	464	118	21	8

b) 20 square meter quadrats (2.52 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	1294	146	55	16	5	3
625	1.000	30734	3417	1232	310	52	15
625	3.000	92196	10247	3691	925	150	40
816	0.042	992	113	42	13	5	3
816	1.000	23541	2618	944	238	41	12
816	3.000	70616	7849	2827	709	116	31
1111	0.042	729	84	32	10	4	3
1111	1.000	17291	1924	694	176	31	10
1111	3.000	51867	5766	2077	522	86	24
1600	0.042	507	59	23	8	4	3
1600	1.000	12007	1337	483	123	22	8
1600	3.000	36016	4004	1443	363	61	17
2500	0.042	326	39	16	6	3	3
2500	1.000	7686	857	310	80	15	6
2500	3.000	23051	2564	925	233	40	12
4444	0.042	184	23	10	5	3	3
4444	1.000	4325	483	176	46	10	5
4444	3.000	12969	1444	522	133	24	8
10000	0.042	84	12	6	4	3	3
10000	1.000	1924	216	80	22	6	4
10000	3.000	5765	643	233	61	12	5

Table 9 continued ...

c) 30 square meter quadrats (3.09 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	863	99	37	12	4	3
625	1.000	20490	2279	822	208	36	11
625	3.000	61465	6832	2461	618	101	28
816	0.042	662	76	29	10	4	3
816	1.000	15695	1746	631	160	28	9
816	3.000	47079	5234	1886	474	78	22
1111	0.042	487	57	22	8	4	3
1111	1.000	11528	1284	464	118	21	8
1111	3.000	34579	3845	1386	349	58	17
1600	0.042	339	40	16	6	3	3
1600	1.000	8006	892	323	83	16	6
1600	3.000	24012	2671	963	243	41	13
2500	0.042	218	27	12	5	3	3
2500	1.000	5125	572	208	54	11	5
2500	3.000	15368	1710	618	157	28	9
4444	0.042	124	16	8	4	3	3
4444	1.000	2884	323	118	32	8	4
4444	3.000	8647	963	349	89	17	6
10000	0.042	57	9	5	3	3	3
10000	1.000	1283	145	54	16	5	3
10000	3.000	3844	430	157	41	9	5

d) 40 square meter quadrats (3.57 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	648	75	29	9	4	3
625	1.000	15368	1710	618	157	28	9
625	3.000	46099	5125	1847	464	77	21
816	0.042	497	58	23	8	4	3
816	1.000	11772	1311	474	121	22	8
816	3.000	35310	3926	1415	356	59	17
1111	0.042	366	43	17	7	3	3
1111	1.000	8647	963	349	89	17	6
1111	3.000	25935	2884	1040	262	44	13
1600	0.042	255	31	13	6	3	3
1600	1.000	6005	670	243	63	13	5
1600	3.000	18009	2004	723	183	32	10
2500	0.042	164	21	9	5	3	3
2500	1.000	3844	430	157	41	9	5
2500	3.000	11527	1283	464	118	21	8
4444	0.042	94	13	7	4	3	3
4444	1.000	2164	243	89	25	6	4
4444	3.000	6486	723	262	68	13	6
10000	0.042	43	7	5	3	3	3
10000	1.000	963	110	41	13	5	3
10000	3.000	2884	323	118	32	8	4

Table 9 continued ...

e) 50 square meter quadrats (3.99 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	519	60	24	8	4	3
625	1.000	12295	1369	495	126	23	8
625	3.000	36880	4100	1478	372	62	18
816	0.042	398	47	19	7	4	3
816	1.000	9418	1049	380	97	18	7
816	3.000	28248	3141	1133	285	48	14
1111	0.042	293	35	15	6	3	3
1111	1.000	6918	771	280	72	14	6
1111	3.000	20748	2308	833	210	36	11
1600	0.042	205	25	11	5	3	3
1600	1.000	4805	536	195	51	11	5
1600	3.000	14408	1603	579	147	26	9
2500	0.042	132	17	8	4	3	3
2500	1.000	3076	344	126	34	8	4
2500	3.000	9222	1027	372	95	18	7
4444	0.042	76	11	6	4	3	3
4444	1.000	1732	195	72	20	6	4
4444	3.000	5189	579	210	55	11	5
10000	0.042	35	7	4	3	3	3
10000	1.000	771	88	34	11	4	3
10000	3.000	2308	259	95	26	7	4

f) 100 square meter quadrats (5.64 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	261	32	13	6	3	3
625	1.000	6149	686	249	64	13	5
625	3.000	18442	2052	740	187	32	10
816	0.042	201	25	11	5	3	3
816	1.000	4710	526	191	50	11	5
816	3.000	14126	1572	568	144	26	9
1111	0.042	148	19	9	4	3	3
1111	1.000	3461	387	141	38	9	4
1111	3.000	10376	1155	418	107	20	7
1600	0.042	104	14	7	4	3	3
1600	1.000	2404	270	99	27	7	4
1600	3.000	7206	803	291	75	15	6
2500	0.042	67	10	6	4	3	3
2500	1.000	1539	174	64	18	5	3
2500	3.000	4613	515	187	49	10	5
4444	0.042	39	7	4	3	3	3
4444	1.000	867	99	38	12	4	3
4444	3.000	2596	291	107	29	7	4
10000	0.042	19	5	4	3	3	3
10000	1.000	387	46	18	7	3	3
10000	3.000	1155	131	49	15	5	3

Table 9 continued ...

g) 150 square meter quadrats (6.91 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	175	22	10	5	3	3
625	1.000	4100	458	167	44	10	5
625	3.000	12295	1369	495	126	23	8
816	0.042	135	18	8	4	3	3
816	1.000	3141	352	128	34	8	4
816	3.000	9418	1049	380	97	18	7
1111	0.042	100	14	7	4	3	3
1111	1.000	2308	259	95	26	7	4
1111	3.000	6918	771	280	72	14	6
1600	0.042	70	10	6	4	3	3
1600	1.000	1603	181	67	19	6	4
1600	3.000	4805	536	195	51	11	5
2500	0.042	46	8	5	3	3	3
2500	1.000	1027	117	44	13	5	3
2500	3.000	3076	344	126	34	8	4
4444	0.042	27	6	4	3	3	3
4444	1.000	579	67	26	9	4	3
4444	3.000	1732	195	72	20	6	4
10000	0.042	14	4	3	3	3	3
10000	1.000	259	31	13	6	3	3
10000	3.000	771	88	34	11	4	3

h) 200 square meter quadrats (7.98 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	132	17	8	4	3	3
625	1.000	3076	344	126	34	8	4
625	3.000	9222	1027	372	95	18	7
816	0.042	102	14	7	4	3	3
816	1.000	2357	264	97	26	7	4
816	3.000	7064	788	285	74	14	6
1111	0.042	76	11	6	4	3	3
1111	1.000	1732	195	72	20	6	4
1111	3.000	5189	579	210	55	11	5
1600	0.042	53	9	5	3	3	3
1600	1.000	1203	136	51	15	5	3
1600	3.000	3604	403	147	39	9	4
2500	0.042	35	7	4	3	3	3
2500	1.000	771	88	34	11	4	3
2500	3.000	2308	259	95	26	7	4
4444	0.042	21	5	4	3	3	3
4444	1.000	435	51	20	7	4	3
4444	3.000	1300	147	55	16	5	3
10000	0.042	11	4	3	3	3	3
10000	1.000	195	24	11	5	3	3
10000	3.000	579	67	26	9	4	3

Table 9 continued ...

i) 300 square meter quadrats (9.77 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	89	13	6	4	3	3
625	1.000	2052	231	85	23	6	4
625	3.000	6149	686	249	64	13	5
816	0.042	69	10	6	4	3	3
816	1.000	1572	177	66	19	6	3
816	3.000	4710	526	191	50	11	5
1111	0.042	51	8	5	3	3	3
1111	1.000	1155	131	49	15	5	3
1111	3.000	3461	387	141	38	9	4
1600	0.042	37	7	4	3	3	3
1600	1.000	803	92	35	11	4	3
1600	3.000	2404	270	99	27	7	4
2500	0.042	24	5	4	3	3	3
2500	1.000	515	60	23	8	4	3
2500	3.000	1539	174	64	18	5	3
4444	0.042	15	4	3	3	3	3
4444	1.000	291	35	15	6	3	3
4444	3.000	867	99	38	12	4	3
10000	0.042	8	3	3	3	3	3
10000	1.000	131	17	8	4	3	3
10000	3.000	387	46	18	7	3	3

Table 10. Sample size table for density sampling (90% confidence): sample sizes required for estimated stand densities (stems/hectare) and tree spatial patterns (V/m = variance/mean ratios) to ensure prescribed allowable percentage sampling errors (PE).

a) 10 square meter quadrats (1.78 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	1820	204	75	21	5	3
625	1.000	43289	4812	1734	435	72	20
625	3.000	129864	14431	5197	1301	210	54
816	0.042	1395	157	58	16	5	3
816	1.000	33157	3686	1329	334	55	16
816	3.000	99467	11054	3981	997	162	42
1111	0.042	1025	116	43	13	4	3
1111	1.000	24354	2708	976	246	41	12
1111	3.000	73057	8120	2925	733	119	32
1600	0.042	713	81	31	10	4	3
1600	1.000	16911	1881	679	171	29	9
1600	3.000	50730	5639	2031	510	84	23
2500	0.042	457	53	21	7	3	3
2500	1.000	10824	1205	435	111	20	7
2500	3.000	32468	3610	1301	327	54	15
4444	0.042	258	31	13	5	3	3
4444	1.000	6090	679	246	63	12	5
4444	3.000	18266	2032	733	185	32	10
10000	0.042	116	15	7	4	3	3
10000	1.000	2708	303	111	29	7	4
10000	3.000	8119	904	327	84	15	6

b) 20 square meter quadrats (2.52 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	911	103	39	12	4	3
625	1.000	21646	2407	868	219	37	11
625	3.000	64933	7217	2600	652	106	28
816	0.042	699	80	30	9	4	3
816	1.000	16580	1844	665	168	29	9
816	3.000	49735	5528	1992	500	82	22
1111	0.042	514	59	23	8	3	3
1111	1.000	12178	1355	489	124	22	7
1111	3.000	36530	4061	1463	368	61	17
1600	0.042	357	42	17	6	3	3
1600	1.000	8457	942	341	87	16	6
1600	3.000	25366	2821	1017	256	43	13
2500	0.042	230	28	12	5	3	3
2500	1.000	5413	604	219	56	11	5
2500	3.000	16235	1806	652	165	28	9
4444	0.042	130	17	8	4	3	3
4444	1.000	3046	341	124	33	7	4
4444	3.000	9134	1017	368	94	17	6
10000	0.042	59	9	5	3	3	3
10000	1.000	1355	153	56	16	5	3
10000	3.000	4061	453	165	43	9	4

Table 10 continued ...

c) 30 square meter quadrats (3.09 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	608	70	27	9	4	3
625	1.000	14431	1606	580	147	25	8
625	3.000	43289	4812	1734	435	72	20
816	0.042	467	54	21	7	3	3
816	1.000	11054	1230	444	113	20	7
816	3.000	33157	3686	1329	334	55	16
1111	0.042	343	40	16	6	3	3
1111	1.000	8120	904	327	84	15	6
1111	3.000	24354	2708	976	246	41	12
1600	0.042	239	29	12	5	3	3
1600	1.000	5639	629	228	59	11	5
1600	3.000	16911	1881	679	171	29	9
2500	0.042	154	19	9	4	3	3
2500	1.000	3610	403	147	38	8	4
2500	3.000	10824	1205	435	111	20	7
4444	0.042	88	12	6	3	3	3
4444	1.000	2032	228	84	23	6	3
4444	3.000	6090	679	246	63	12	5
10000	0.042	40	7	4	3	3	3
10000	1.000	904	103	38	11	4	3
10000	3.000	2708	303	111	29	7	4

d) 40 square meter quadrats (3.57 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	457	53	21	7	3	3
625	1.000	10824	1205	435	111	20	7
625	3.000	32468	3610	1301	327	54	15
816	0.042	350	41	16	6	3	3
816	1.000	8291	923	334	85	16	6
816	3.000	24869	2765	997	251	42	12
1111	0.042	258	31	13	5	3	3
1111	1.000	6090	679	246	63	12	5
1111	3.000	18266	2032	733	185	32	10
1600	0.042	180	22	10	4	3	3
1600	1.000	4230	472	171	45	9	4
1600	3.000	12684	1411	510	129	23	8
2500	0.042	116	15	7	4	3	3
2500	1.000	2708	303	111	29	7	4
2500	3.000	8119	904	327	84	15	6
4444	0.042	66	10	5	3	3	3
4444	1.000	1524	171	63	18	5	3
4444	3.000	4568	510	185	48	10	4
10000	0.042	31	6	4	3	3	3
10000	1.000	679	78	29	9	4	3
10000	3.000	2031	228	84	23	6	3

Table 10 continued ...

e) 50 square meter quadrats (3.99 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	366	43	17	6	3	3
625	1.000	8660	964	349	89	16	6
625	3.000	25975	2888	1041	262	44	13
816	0.042	281	33	14	5	3	3
816	1.000	6633	739	268	69	13	5
816	3.000	19895	2213	798	201	34	10
1111	0.042	207	25	11	5	3	3
1111	1.000	4873	543	197	51	10	4
1111	3.000	14613	1626	587	148	26	8
1600	0.042	144	18	8	4	3	3
1600	1.000	3384	378	138	36	8	4
1600	3.000	10148	1130	408	104	19	7
2500	0.042	93	13	6	3	3	3
2500	1.000	2167	243	89	24	6	3
2500	3.000	6495	724	262	67	13	5
4444	0.042	54	8	5	3	3	3
4444	1.000	1220	138	51	15	4	3
4444	3.000	3655	408	148	39	8	4
10000	0.042	25	5	3	3	3	3
10000	1.000	543	62	24	8	3	3
10000	3.000	1626	183	67	19	5	3

f) 100 square meter quadrats (5.64 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	184	23	10	4	3	3
625	1.000	4331	483	176	46	9	4
625	3.000	12989	1445	522	132	23	8
816	0.042	142	18	8	4	3	3
816	1.000	3318	371	135	36	8	4
816	3.000	9949	1108	400	102	18	6
1111	0.042	105	14	7	4	3	3
1111	1.000	2437	273	100	27	6	4
1111	3.000	7308	814	295	75	14	5
1600	0.042	73	10	5	3	3	3
1600	1.000	1693	190	70	19	5	3
1600	3.000	5075	566	205	53	11	5
2500	0.042	48	8	4	3	3	3
2500	1.000	1085	123	46	13	4	3
2500	3.000	3249	363	132	35	8	4
4444	0.042	28	5	4	3	3	3
4444	1.000	611	70	27	9	4	3
4444	3.000	1829	205	75	21	5	3
10000	0.042	14	4	3	3	3	3
10000	1.000	273	32	13	5	3	3
10000	3.000	814	93	35	11	4	3

g) 150 square meter quadrats (6.91 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	124	16	7	4	3	3
625	1.000	2888	323	118	31	7	4
625	3.000	8660	964	349	89	16	6
816	0.042	95	13	6	3	3	3
816	1.000	2213	248	91	24	6	3
816	3.000	6633	739	268	69	13	5
1111	0.042	71	10	5	3	3	3
1111	1.000	1626	183	67	19	5	3
1111	3.000	4873	543	197	51	10	4
1600	0.042	50	8	4	3	3	3
1600	1.000	1130	128	47	14	4	3
1600	3.000	3384	378	138	36	8	4
2500	0.042	33	6	4	3	3	3
2500	1.000	724	83	31	10	4	3
2500	3.000	2167	243	89	24	6	3
4444	0.042	19	4	3	3	3	3
4444	1.000	408	47	19	7	3	3
4444	3.000	1220	138	51	15	4	3
10000	0.042	10	3	3	3	3	3
10000	1.000	183	22	10	4	3	3
10000	3.000	543	62	24	8	3	3

h) 200 square meter quadrats (7.98 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	93	13	6	3	3	3
625	1.000	2167	243	89	24	6	3
625	3.000	6495	724	262	67	13	5
816	0.042	72	10	5	3	3	3
816	1.000	1660	187	69	19	5	3
816	3.000	4976	555	201	52	10	5
1111	0.042	54	8	5	3	3	3
1111	1.000	1220	138	51	15	4	3
1111	3.000	3655	408	148	39	8	4
1600	0.042	38	6	4	3	3	3
1600	1.000	848	96	36	11	4	3
1600	3.000	2539	284	104	28	7	4
2500	0.042	25	5	3	3	3	3
2500	1.000	543	62	24	8	3	3
2500	3.000	1626	183	67	19	5	3
4444	0.042	15	4	3	3	3	3
4444	1.000	307	36	15	6	3	3
4444	3.000	916	104	39	12	4	3
10000	0.042	8	3	3	3	3	3
10000	1.000	138	17	8	4	3	3
10000	3.000	408	47	19	7	3	3

Table 10 continued ...

i) 300 square meter quadrats (9.77 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	63	9	5	3	3	3
625	1.000	1445	163	60	17	5	3
625	3.000	4331	483	176	46	9	4
816	0.042	49	8	4	3	3	3
816	1.000	1108	125	47	13	4	3
816	3.000	3318	371	135	36	8	4
1111	0.042	36	6	4	3	3	3
1111	1.000	814	93	35	11	4	3
1111	3.000	2437	273	100	27	6	4
1600	0.042	26	5	3	3	3	3
1600	1.000	566	65	25	8	3	3
1600	3.000	1693	190	70	19	5	3
2500	0.042	18	4	3	3	3	3
2500	1.000	363	42	17	6	3	3
2500	3.000	1085	123	46	13	4	3
4444	0.042	11	3	3	3	3	3
4444	1.000	205	25	11	5	3	3
4444	3.000	611	70	27	9	4	3
10000	0.042	6	3	3	3	3	3
10000	1.000	93	12	6	3	3	3
10000	3.000	273	32	13	5	3	3

Table 11. Sample size table for density sampling (80% confidence): sample sizes required for estimated stand densities (stems/hectare) and tree spatial patterns (V/m = variance/mean ratios) to ensure prescribed allowable percentage sampling errors (PE).

a) 10 square meter quadrats (1.78 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	1105	124	46	13	4	3
625	1.000	26280	2922	1053	265	44	12
625	3.000	78835	8761	3155	790	128	33
816	0.042	847	96	36	10	3	3
816	1.000	20129	2238	807	203	34	10
816	3.000	60383	6711	2417	606	98	26
1111	0.042	623	71	27	8	3	3
1111	1.000	14785	1644	593	150	26	8
1111	3.000	44350	4929	1776	445	73	20
1600	0.042	433	50	19	6	3	3
1600	1.000	10267	1142	412	104	18	6
1600	3.000	30796	3423	1234	310	51	14
2500	0.042	278	33	13	5	3	3
2500	1.000	6571	732	265	68	12	5
2500	3.000	19710	2192	790	199	33	10
4444	0.042	157	19	8	4	3	3
4444	1.000	3697	412	150	39	8	4
4444	3.000	11089	1234	445	113	20	6
10000	0.042	71	10	5	3	3	3
10000	1.000	1644	184	68	18	5	3
10000	3.000	4929	549	199	51	10	4

b) 20 square meter quadrats (2.52 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	554	63	24	7	3	3
625	1.000	13141	1462	527	133	23	7
625	3.000	39418	4381	1578	396	65	18
816	0.042	424	49	19	6	3	3
816	1.000	10065	1120	404	102	18	6
816	3.000	30192	3356	1209	304	50	14
1111	0.042	312	36	14	5	3	3
1111	1.000	7393	823	297	76	14	5
1111	3.000	22176	2466	889	224	37	11
1600	0.042	217	26	11	4	3	3
1600	1.000	5134	572	207	53	10	4
1600	3.000	15399	1713	618	156	26	6
2500	0.042	140	17	7	3	3	3
2500	1.000	3287	367	133	35	7	3
2500	3.000	9856	1097	396	100	18	6
4444	0.042	79	11	5	3	3	3
4444	1.000	1850	207	76	20	5	3
4444	3.000	5545	618	224	57	11	4
10000	0.042	36	6	3	3	3	3
10000	1.000	823	93	35	10	3	3
10000	3.000	2465	276	100	26	6	3

Table 11 continued ...

c) 30 square meter quadrats (3.09 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	370	43	17	6	3	3
625	1.000	8761	975	352	89	16	6
625	3.000	26280	2922	1053	265	44	12
816	0.042	284	33	13	5	3	3
816	1.000	6711	747	270	69	13	5
816	3.000	20129	2238	807	203	34	10
1111	0.042	209	25	10	4	3	3
1111	1.000	4929	549	199	51	10	4
1111	3.000	14785	1644	593	150	26	8
1600	0.042	146	18	8	4	3	3
1600	1.000	3423	382	139	36	7	3
1600	3.000	10267	1142	412	104	18	6
2500	0.042	94	12	6	3	3	3
2500	1.000	2192	245	89	24	6	3
2500	3.000	6571	732	265	68	12	5
4444	0.042	54	8	4	3	3	3
4444	1.000	1234	139	51	14	4	3
4444	3.000	3697	412	150	39	8	4
10000	0.042	25	5	3	3	3	3
10000	1.000	549	63	24	7	3	3
10000	3.000	1644	184	68	18	5	3

d) 40 square meter quadrats (3.57 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	278	33	13	5	3	3
625	1.000	6571	732	265	68	12	5
625	3.000	19710	2192	790	199	33	10
816	0.042	213	25	10	4	3	3
816	1.000	5034	561	203	52	10	4
816	3.000	15097	1679	606	153	26	8
1111	0.042	157	19	8	4	3	3
1111	1.000	3697	412	150	39	8	4
1111	3.000	11089	1234	445	113	20	6
1600	0.042	110	14	6	3	3	3
1600	1.000	2568	287	104	28	6	3
1600	3.000	7700	857	310	79	14	5
2500	0.042	71	10	5	3	3	3
2500	1.000	1644	184	68	18	5	3
2500	3.000	4929	549	199	51	10	4
4444	0.042	41	6	4	3	3	3
4444	1.000	926	104	39	11	4	3
4444	3.000	2774	310	113	30	6	3
10000	0.042	19	4	3	3	3	3
10000	1.000	412	47	18	6	3	3
10000	3.000	1234	139	51	14	4	3

e) 50 square meter quadrats (3.99 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	223	26	11	4	3	3
625	1.000	5257	586	212	54	10	4
625	3.000	15768	1754	632	159	27	8
816	0.042	171	21	9	4	3	3
816	1.000	4027	449	163	42	8	4
816	3.000	12078	1344	485	123	21	7
1111	0.042	126	16	7	3	3	3
1111	1.000	2958	330	120	31	7	3
1111	3.000	8871	987	357	91	16	6
1600	0.042	88	11	5	3	3	3
1600	1.000	2055	230	84	22	5	3
1600	3.000	6161	686	248	63	12	5
2500	0.042	57	8	4	3	3	3
2500	1.000	1316	148	54	15	4	3
2500	3.000	3943	440	159	41	8	4
4444	0.042	33	5	3	3	3	3
4444	1.000	741	84	31	9	3	3
4444	3.000	2219	248	91	24	6	3
10000	0.042	16	4	3	3	3	3
10000	1.000	330	38	15	5	3	3
10000	3.000	987	111	41	12	4	3

f) 100 square meter quadrats (5.64 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	112	14	6	3	3	3
625	1.000	2630	294	107	28	6	3
625	3.000	7885	878	317	81	15	5
816	0.042	86	11	5	3	3	3
816	1.000	2015	225	82	22	5	3
816	3.000	6040	673	243	62	12	4
1111	0.042	64	9	5	3	3	3
1111	1.000	1480	166	61	17	4	3
1111	3.000	4437	495	179	46	9	4
1600	0.042	45	7	4	3	3	3
1600	1.000	1028	116	43	12	4	3
1600	3.000	3081	344	125	33	7	3
2500	0.042	29	5	3	3	3	3
2500	1.000	659	75	28	9	3	3
2500	3.000	1973	221	81	22	5	3
4444	0.042	17	4	3	3	3	3
4444	1.000	371	43	17	6	3	3
4444	3.000	1111	125	46	13	4	3
10000	0.042	9	3	3	3	3	3
10000	1.000	166	20	9	4	3	3
10000	3.000	495	57	22	7	3	3

Table 11 continued ...

g) 150 square meter quadrats (6.91 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	75	10	5	3	3	3
625	1.000	1754	196	72	19	5	3
625	3.000	5257	586	212	54	10	4
816	0.042	58	8	4	3	3	3
816	1.000	1344	151	56	15	4	3
816	3.000	4027	449	163	42	8	4
1111	0.042	43	7	4	3	3	3
1111	1.000	987	111	41	12	4	3
1111	3.000	2958	330	120	31	7	3
1600	0.042	31	5	3	3	3	3
1600	1.000	686	78	29	9	3	3
1600	3.000	2055	230	84	22	5	3
2500	0.042	20	4	3	3	3	3
2500	1.000	440	51	19	6	3	3
2500	3.000	1316	148	54	15	4	3
4444	0.042	12	3	3	3	3	3
4444	1.000	248	29	12	5	3	3
4444	3.000	741	84	31	9	3	3
10000	0.042	7	3	3	3	3	3
10000	1.000	111	14	6	3	3	3
10000	3.000	330	38	15	5	3	3

h) 200 square meter quadrats (7.98 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	57	8	4	3	3	3
625	1.000	1316	148	54	15	4	3
625	3.000	3943	440	159	41	8	4
816	0.042	44	7	4	3	3	3
816	1.000	1008	114	42	12	4	3
816	3.000	3021	337	123	32	7	3
1111	0.042	33	5	3	3	3	3
1111	1.000	741	84	31	9	3	3
1111	3.000	2219	248	91	24	6	3
1600	0.042	23	4	3	3	3	3
1600	1.000	515	59	22	7	3	3
1600	3.000	1542	173	63	17	5	3
2500	0.042	16	4	3	3	3	3
2500	1.000	330	38	15	5	3	3
2500	3.000	987	111	41	12	4	3
4444	0.042	10	3	3	3	3	3
4444	1.000	187	22	9	4	3	3
4444	3.000	556	63	24	7	3	3
10000	0.042	5	3	3	3	3	3
10000	1.000	84	11	5	3	3	3
10000	3.000	248	29	12	5	3	3

i) 300 square meter quadrats (9.77 meter radius)

Density	Spacing (V/m)	Sample size: PE = 1%	Sample size: PE = 3%	Sample size: PE = 5%	Sample size: PE =10%	Sample size: PE =25%	Sample size: PE =50%
625	0.042	39	6	4	3	3	3
625	1.000	878	99	37	11	4	3
625	3.000	2630	294	107	28	6	3
816	0.042	30	5	3	3	3	3
816	1.000	673	76	29	9	3	3
816	3.000	2015	225	82	22	5	3
1111	0.042	23	4	3	3	3	3
1111	1.000	495	57	22	7	3	3
1111	3.000	1480	166	61	17	4	3
1600	0.042	16	4	3	3	3	3
1600	1.000	344	40	16	5	3	3
1600	3.000	1028	116	43	12	4	3
2500	0.042	11	3	3	3	3	3
2500	1.000	221	26	11	4	3	3
2500	3.000	659	75	28	9	3	3
4444	0.042	7	3	3	3	3	3
4444	1.000	125	16	7	3	3	3
4444	3.000	371	43	17	6	3	3
10000	0.042	4	3	3	3	3	3
10000	1.000	57	8	4	3	3	3
10000	3.000	166	20	9	4	3	3

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